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I also certify that the application is now proceeding in the name as identified herein.

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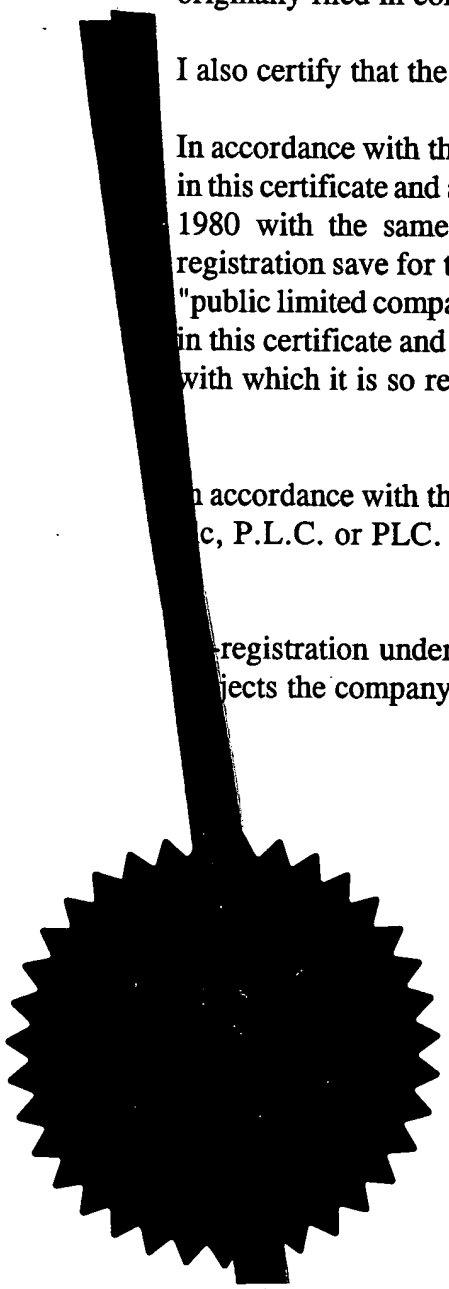

Signed William Morell

Dated 10 May 2005

GB 0221706.5

By virtue of a direction given under Section 32 of the Patents Act 1977, the application is proceeding in the name of:

VETCO GRAY CONTROLS LIMITED,
2 High Street,
Nailsea,
BRISTOL,
BS48 1BS,
United Kingdom

Incorporated in the United Kingdom,

[ADP No. 08927220001]
~~Incorporated in the United Kingdom,~~

~~[ADP No. 08901696001]~~

Patents Form 1/77

Patents Act 1977
(Rule 16)

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1/77

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

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Cardiff Road
Newport
South Wales
NP9 1RH

1. Your reference — MJN/67945/000

195EP02 E749373-3 D01914
P01/7700 0.00-0221706.5

2. Patent application number
(The Patent Office will fill in this part) — 0221706.5

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

ABB Offshore Systems Limited
2 High Street
Nailsea
Bristol BS48 1BS

7/9/04

SECTION 32 (1977 ACT) APPLICATION FILED

Patents ADP number *(if you know it)* 7697222100 1

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom (GB)

4. Title of the invention — PRESSURE SENSING APPARATUS

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

PAGE HARGRAVE
Southgate, Whitefriars
Lewins Mead
BRISTOL BS1 2NT

Patents ADP number *(if you know it)* — 05996483001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	-
Description	4
Claim *(s)*	2
Abstract	1
Drawing *(s)*	2+2

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10. If you are also filing any of the following, state how many against each item.

Priority documents	-
Translations of priority documents	-
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	Two
Request for preliminary examination and search *(Patents Form 9/77)*	One
Request for substantive examination *(Patents Form 10/77)*	-
Any other documents *(please specify)*	-

11. I/We request the grant of a patent on the basis of this application.

Signature PAGE HARGRAVE Date 17/09/02

12. Name and daytime telephone number of person to contact in the United Kingdom: Mr M J Newstead (0117) 927 6634

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Patents Form 7/77

Patents Act 1977
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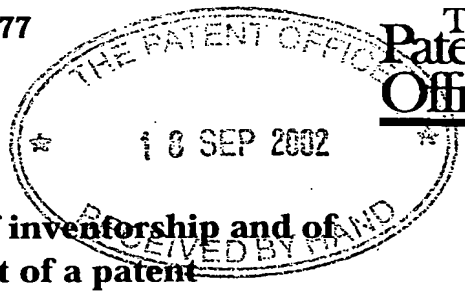

The Patent Office

7/77

Statement of inventorship and of right to grant of a patent

The Patent Office

Cardiff Road
Newport
South Wales
NP9 1RH

1. Your reference	MJN/67945/000
2. Patent application number *(if you know it)*	0221706.5
3. Full name of the or of each applicant	ABB Offshore Systems Limited
4. Title of the invention	PRESSURE SENSING APPARATUS
5. State how the applicant *(s)* derived the right from the inventor *(s)* to be granted a patent	By virtue of a contract of employment between the applicant and the inventor.
6. How many, if any, additional Patents Forms 7/77 are attached to this form? *(see note (c))*	-
7.	I/We believe that the person *(s)* named over the page *(and on any extra copies of this form)* is/are the inventor *(s)* of the invention which the above patent application relates to. Signature Paul Hargrave Date 17/09/02 PAGE HARGRAVE
8. Name and daytime telephone number of person to contact in the United Kingdom	Mr M J Newstead (0117) 927 6634

Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.

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Enter the full names, addresses and postcodes of the inventors in the boxes and underline the surnames

James Brian Wilson
2 Russett Grove
Nailsea
North Somerset BS48 4GB
United Kingdom (GB)

3724523003

Patents ADP number *(if you know it):*

Patents ADP number *(if you know it):*

Patents ADP number *(if you know it):*

Reminder

Have you signed the form?

PRESSURE SENSING APPARATUS

The present invention relates to pressure sensing apparatus, for example for sensing pressure in a fluid extraction well such as a hydrocarbon extraction well.

Fig. 1 shows, diagrammatically in section, typical existing pressure sensing apparatus as an assembly 1 fitted in a hydrocarbon production fluid extraction well. The assembly 1 is typically attached to the wall of a fluid extraction pipe 2 via a flange 3. In order to prevent the fluid flow of wellbore product whose pressure is to be sensed from contaminating and blocking the pressure sensing aperture, a flush diaphragm 4 is fitted over the aperture, the diaphragm hydraulically connecting to a remote pressure sensor 5, in the example a quartz device, via a hydraulic, oil filled, very small bore, tubing 6 and hydraulic oil in a cavity 7 defined by a funnel 8. The pressure sensor 5 is located close to an electronic unit 9 which contains an oscillator for the quartz device and converts the electrical output of the pressure sensor 5 into a form suitable for transmission remotely from the assembly 1. The hydraulic tube 6 connecting the diaphragm 4 to the pressure sensor 5 is typically fitted with a facility 10 to evacuate it and permit filling the tube with hydraulic fluid. The pressure sensor 5 and electronic unit 9 are mounted at the cool end of the assembly 1 (that is in a cool environment, e.g. sea water, as compared with the inside of pipe 2), in order to maximise the life of the assembly.

A problem with such pressure sensor assemblies is that there is a differential thermal expansion between the tube 6 and the hydraulic fluid in the tube, causing errors in pressure measurements. Although some attempt is often made to compensate for this by adjustment in the electronics, this is generally inadequate, particularly under transient conditions, leaving significant errors in pressure measurement.

According to the present invention, there is provided pressure sensing apparatus comprising:

pressure responsive means; and

hydraulic connecting means hydraulically connecting the pressure responsive means with pressure sensing means which produces an indication of sensed pressure, wherein:

the hydraulic connecting means comprises a tubular member and a longitudinal insert in the tubular member with hydraulic fluid in the tubular member between the insert and the member, the tubular member, the insert and the hydraulic fluid and the dimensions of the tubular member and the insert being such that the pressure transmitted hydraulic fluid to the sensing means in use of the apparatus is substantially independent of temperature changes.

Preferably, the tubular member is metallic.

The insert may be in the form of a rod.

Preferably, the volumetric coefficient of thermal expansion of the material of the tubular member is less than that of the hydraulic fluid and greater than that of the material of the insert. For example, the volumetric coefficient of thermal expansion of the material of the tubular member could be substantially 30 x 10^{-6}/°C, that of the material of the insert substantially 0.5 x 10^{-6}/°C and that of the hydraulic fluid substantially 300 x 10^{-6}/°C, the insert occupying substantially 95% of the internal volume of the tubular member.

The pressure responsive means could comprise a diaphragm.

The pressure sensing means could comprise a pressure sensor and electronic circuitry connected with it.

Fig. 2 shows a sectioned view of a metal tube 11 for use instead of tube 6 in Fig. 1. The tube 11 is made of metal with a volumetric thermal co-efficient of expansion of typically 30 x 10^{-6}/ °C. Inserted in the tube 11 is a longitudinal insert in the form of a rod 12, typically made of silica, which is smaller in diameter than the inner diameter of the tube 11 and has, typically, a volumetric thermal co-efficient of 0.5 x 10^{-6}/ °C. The annular space 13, between the tube 11 and the rod 12, is filled with hydraulic fluid (e.g.

oil)which, typically, has a volumetric thermal co-efficient of expansion of 300 x 10^{-6}/ °C. When the temperature of the tube 11 increases, the volume of space 13 increases in dependence on the difference between the volumetric thermal co-efficients of expansion of the tube 11 and the rod 12. The internal diameter of the tube 11 and diameter of the rod 12 are arranged such that the increase of volume of space 13 for a given rise in temperature substantially matches the increase in space of the hydraulic oil filling this volume, for the same temperature rise. As the two volume increases substantially match, there is substantially no change in pressure applied by the hydraulic fluid due to a temperature rise, irrespective of the length of the tube 11. The same situation applies to a fall in temperature of the tube 11. Thus, the hydraulic fluid will transmit the pressure from a diaphragm to a pressure sensor substantially without errors resulting from temperature changes of the tube 11, the pressure transmitted by the fluid being substantially independent of temperature. Typically, with the examples of temperature co-efficients quoted, the rod 12 will need to occupy substantially 95% of the internal volume of the metal tube 11. The percentages can be calculated once the precise expansion rates for the actual choice of the different materials employed to implement the tube 11 and rod 12 are known.

The above temperature compensation of pressure changes due to thermal changes is irrespective of the overall diameter of tube 11, which can be of any diameter required. Thus it can be made large enough to remove the problems of contamination blockages of the very small bore tubes traditionally needed, by ensuring that the space 13 for the hydraulic fluid is substantial.

Fig. 3, in which items which correspond with those in Fig. 1 have the same reference numerals, shows pressure sensing apparatus in the form of an assembly 14 in which, instead of a small bore tubing 6, there is a tube 11 with a rod 12 as described above, hydraulically connecting diaphragm 4 with pressure sensor 5. Longitudinal expansion of the tube 11 and rod 12 can be accommodated by appropriate mounting of the pressure sensor 5 and electronic unit 7.

Suitable materials for the rod insert 12 have a very low coefficient of thermal expansion

and are incompressible at the working pressure of the assembly 14. Although silica is one such material, there may also be other suitable materials such as some grades of glass (Pyrex) and ceramic and some exotic metals (Invar) that can perform the required function equally as well.

CLAIMS

1. Pressure sensing apparatus comprising:

pressure responsive means; and

hydraulic connecting means hydraulically connecting the pressure responsive means with pressure sensing means which produces an indication of sensed pressure, wherein:

the hydraulic connecting means comprises a tubular member and a longitudinal insert in the tubular member with hydraulic fluid in the tubular member between the insert and the member, the tubular member, the insert and the hydraulic fluid and the dimensions of the tubular member and the insert being such that the pressure transmitted the hydraulic fluid to the sensing means in use of the apparatus is substantially independent of temperature changes.

2. Apparatus according to claim 1, wherein the tubular member is metallic.

3. Apparatus according to claim 1 or 2, wherein the insert is in the form of a rod.

4. Apparatus according to any preceding claim, wherein the volumetric coefficient of thermal expansion of the material of the tubular member is less than that of the hydraulic fluid and greater than that of the material of the insert.

5. Apparatus according to claim 4, wherein the volumetric coefficient of thermal expansion of the material of the tubular member is substantially $30 \times 10^{-6}/°C$, that of the material of the insert is substantially $0.5 \times 10^{-6}/°C$, that of the hydraulic fluid is substantially $300 \times 10^{-6}/°C$ and the insert occupies substantially 95% of the internal volume of the tubular member.

6. Apparatus according to any preceding claim, wherein the pressure responsive means comprises a diaphragm.

7. Apparatus according to any preceding claim, wherein the pressure sensing

means comprises a pressure sensor and electronic circuitry connected with it.

ABSTRACT

Pressure sensing apparatus (14) comprises pressure responsive means (4) and hydraulic connecting means (11, 12, 13) hydraulically connecting the pressure responsive means with pressure sensing means (5, 9) which produces an indication of sensed pressure. The hydraulic connecting means comprises a tubular member (11) and a longitudinal insert (12) in the tubular member with hydraulic fluid in the tubular member between the insert and the member, the tubular member, the insert and the hydraulic fluid and the dimensions of the tubular member and the insert being such that the pressure transmitted the hydraulic fluid to the sensing means in use of the apparatus is substantially independent of temperature changes.

(Fig. 3)

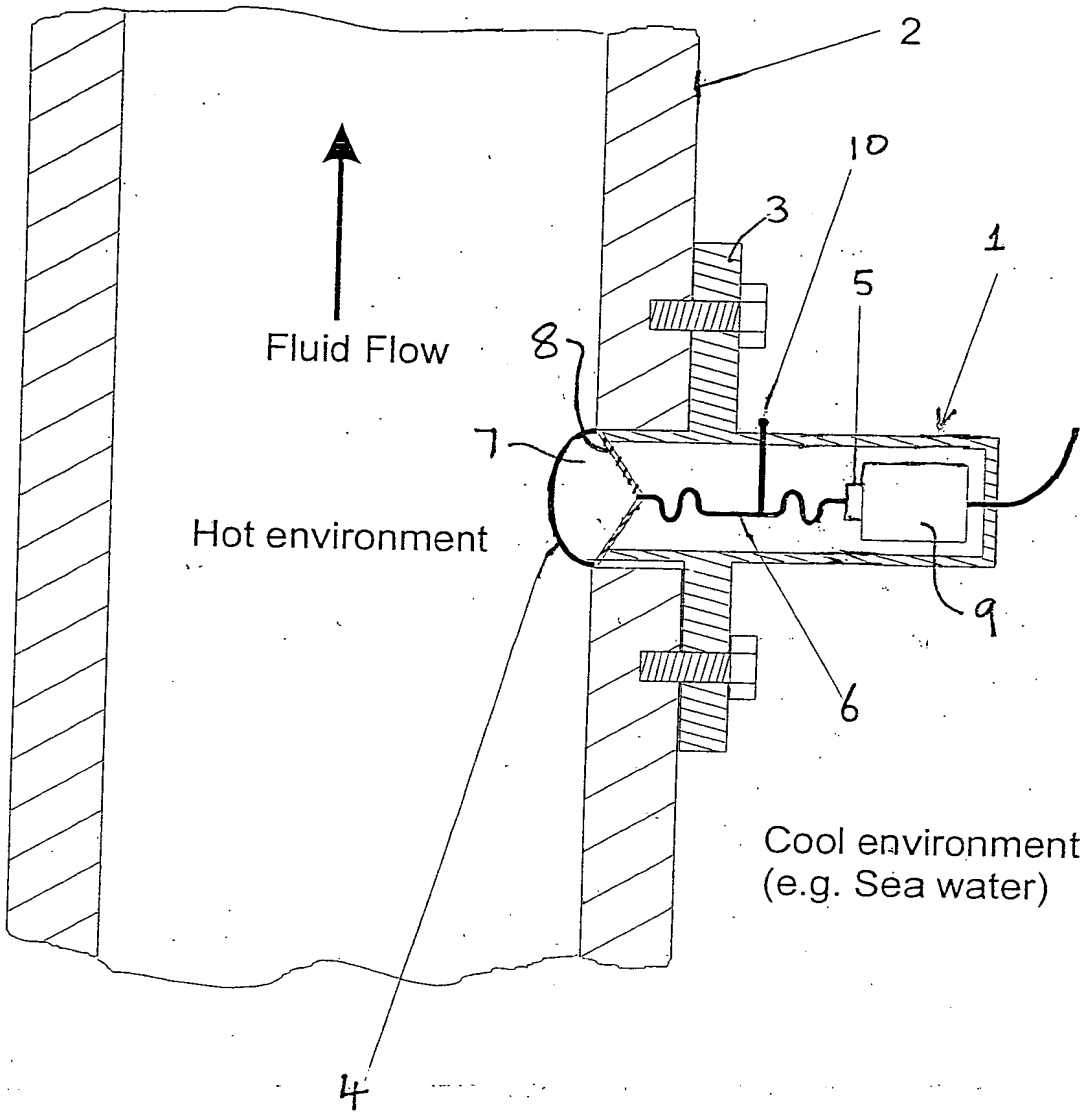
2
10
3
1
5
Fluid Flow
8
7
Hot environment
9
6
Cool environment
(e.g. Sea water)
4

Fig. 1

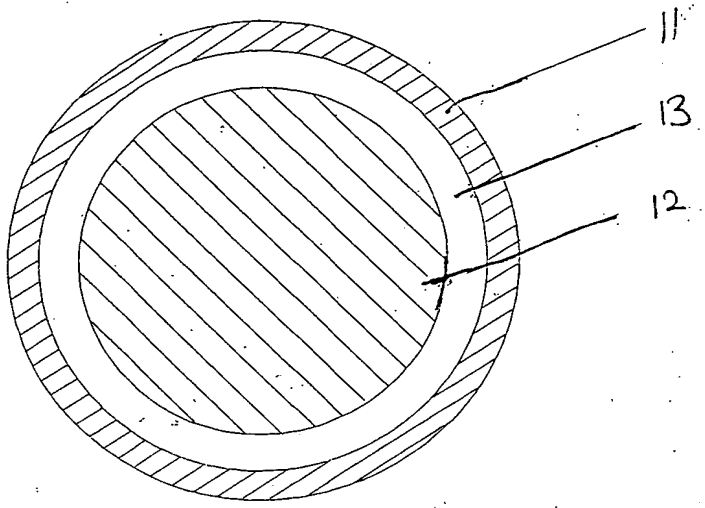

Fig. 2

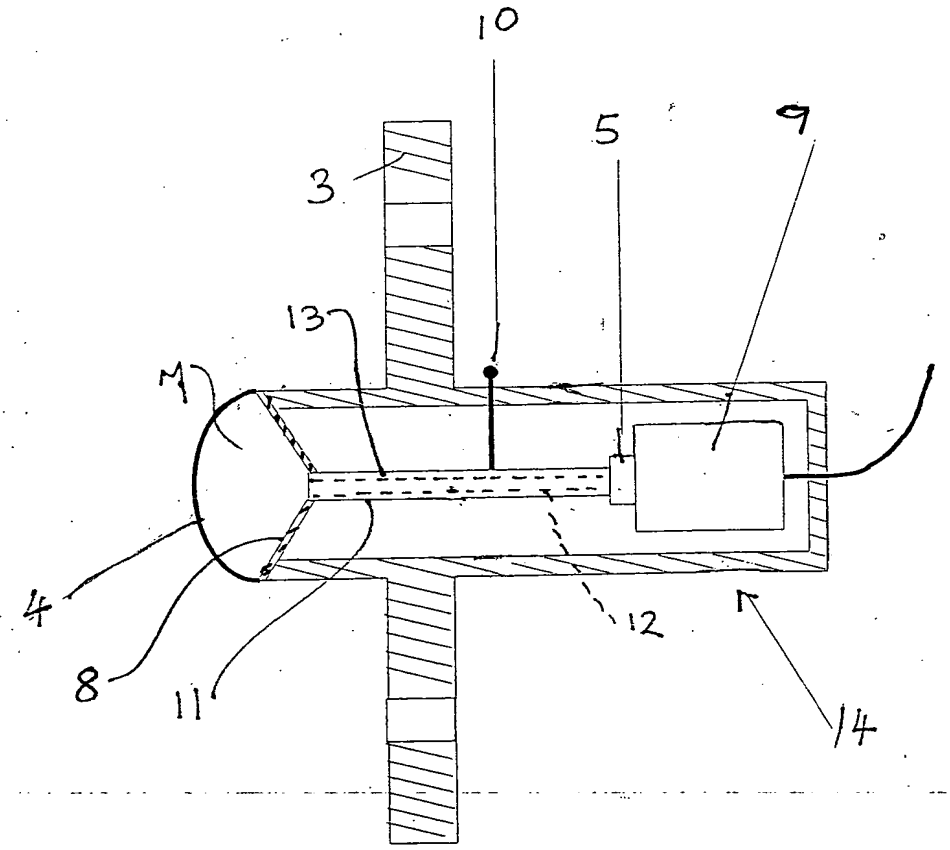

Fig. 3